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Rocket Artillery Launch Spotter (RLS)

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The Threat: A common form of attack during current operations in Afghanistan and Iraq is the use of hit-and-run mortar and/or rocket strikes on coalition forces and bases, or on locations associated with the provisional governments in these countries. The insurgents fire mortars or rockets and then quickly escape before their presence is noticed. Rocket artillery can be exceptionally deadly, since the supersonic speeds of these weapons often result in an impact well before the launch is detected acoustically.

Rocket Launch Spotter (RLS): Shortly after entering Iraq, the U.S. Marine Corps issued an Urgent Needs Statement requesting an affordable, expeditionary, and unattended system to rapidly detect, provide warning, and report the point-of-origin (POO) of a rocket launch. The system was needed for Forward Operating Base (FOB) protection in Iraq and Afghanistan. The Office of Naval Research (ONR) Swampworks funded NRL for the rapid development and testing of an Operational Experimentation Article for launch detection. The selected design uses tower-based infrared and acoustic subsystems. The system leverages technology designed for use in another NRL project, Tactical Aircraft Directed Infra-Red Countermeasures (TADIRCM). The two-color infrared sensors are designed to detect surface-to-air missiles for TADIRCM and are used to detect rocket artillery in RLS. Other TADIRCM components used in RLS include the computer processors, inertial navigation units

(INU), and detection and tracking algorithms. The RLS system uses two TADIRCM sensors, an INU, and a smaller field-of-view single-color forward-looking infrared (FLIR) camera on each tower. Figure 1 shows a typical arrangement. The sensors are aligned to the INU to provide accurate azimuth and elevation of any potential threats detected. The INU includes a GPS receiver to provide accurate location of the tower. The system uses three towers separated by a distance of 2-3 km in a configuration that provides 360° coverage of the area to be protected. Figure 2 shows a typical arrangement. The towers are connected to a control station via a wireless network. From its sensors, each tower reports potential threats to the control station. The control station compares potential threats detected on one tower to potential threats detected on one of the other towers. For threats that correlate, the system designates a correlated threat, triangulates to provide the POO, and reports the POO to an operator via a map display. When a correlated threat is designated, the system automatically cues the FLIR camera on the nearest tower to the correct elevation and azimuth. This provides the operator with video of the launch location within 2 s. When not in a threat condition, the FLIR cameras are available to the operator as surveillance cameras.

To detect mortar launches, the RLS system uses an acoustic subsystem. The acoustic subsystem consists of an Unattended Transient Acoustic Measurement and Signal Intelligence (MASINT) System (UTAMS) developed by the Army Research Laboratory that is currently in use in Iraq. In the RLS system, each tower has one UTAMS microphone array at the top of each tower, as shown in Fig. 3. Each array consists of four microphones and processing equipment. Analyzing the time delays between an acoustic wavefront's interaction with each microphone in the array UTAMS provides an azimuth of origin. The azimuth from each tower is reported to the UTAMS processor at the control station, and a POO is triangulated and displayed. The UTAMS subsystem can also detect and locate the point-of-impact (POI). Because of sound speed limitations,



FIGURE 1

View of IR sensors, FLIR, and tower head arrangement.

FIGURE 2
Typical tower arrangement around
protected area.

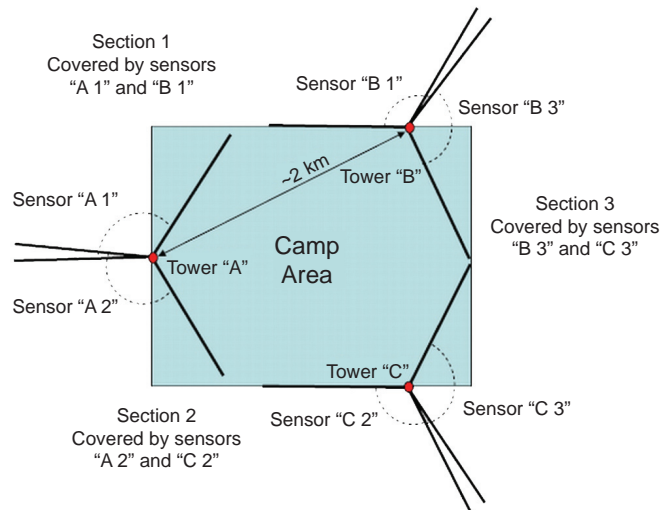


FIGURE 3
UTAMS array attached to tower head.

the time to detect and report the POO can be up to 30 s for a 13-km launch. For rocket artillery, UTAMS often detects the POI prior to the POO, providing very little if any warning time.

The towers used in the RLS system are commercially obtainable heavy-duty all-terrain portable tower systems. Each tower can be raised to a height of 32 m and is capable of lifting a payload of 250 kg. Figure 4 shows the tower in its raised and lowered positions. The towers can be operated in winds up to 100 kts, is C-130 aircraft transportable, and can be erected in less than 30 min once in position. Each tower is powered with a 7.5 kW generator that can run continuously for 4 days between refueling. Once raised, the tower head can be rotated remotely to adjust the sensor coverage and overlap between towers.

System Performance: Testing of the RLS system is currently in progress. Preliminary tests were conducted at NRL in October 2005. A stimulator was used to simulate rocket launches. The infrared subsystem performed as expected, detecting and geo-locating the simulated rocket launches within expected errors. However, the physical constraints of the laboratory prevent the towers from being placed at their optimum separation. The system was also tested at Yuma Proving Ground (Arizona) in November 2005. Last-minute changes to the testing schedule prevented the system from being tested against the design rocket threats. However, the UTAMS performed well against mortar firings, and the RLS infrared system again geo-located simulated targets within expected position errors. The Yuma tests also provided extensive false-alarm testing.



(a) Raised position



(b) Lowered position

FIGURE 4
Portable tower position.

The false-alarm rate of the system was determined to be extremely low. Additional testing is currently under way at NRL.

Conclusions: The RLS system provides an expeditionary, unattended, and rapid rocket detection capability for the protection of FOB's. The system can provide long warning times and accurate POO information for rocket threats and moderate warning

times for mortar threats. Current plans include further testing against design threats in early 2006, and possible integration of the system with the Critical Area Protection System currently in use in Iraq by the Marines. Longer range plans include the use of higher-speed processors to allow the infrared subsystem to also detect and geo-locate mortars, rocket-propelled grenades, and machine-gun fire.

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